

Single-Particle Occupancies Around the N = 40 Shell Closure Using Knockout Reactions

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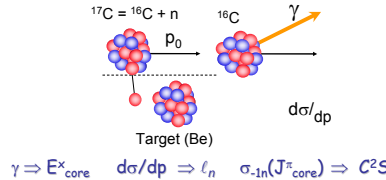
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Abstract

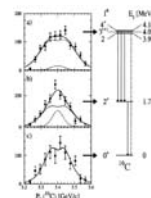
Recent experiments on light neutron-rich atomic nuclei have indicated neutron sub-shell closures different than those known for stable nuclei ("neutron magic numbers" N=8, N=20, N=28). For heavier neutron-rich nuclei, a shell gap at N=40 is suggested rather than at N=50. An experiment was performed at GSI in May 2005 which had the goal to study the neutron-rich ^{68,70,72}Ni (Z=28, N=40-44) isotopic chain. This experiment aims to shed light on the N=40 region where contradictory results have been found by recent experiments. The Ni isotopes were studied by knockout and quasifree scattering reactions and single-particle occupancies will be extracted. The knockout reactions were performed with stable and radioactive Ni beams in inverse kinematics on a CH₂ target. The measurement of the longitudinal momentum distribution of the projectile fragments after removal of one neutron determines the angular momentum of the removed particle, while γ -coincidence measurements enable the identification of the final state and hence the extraction of partial cross sections from which the occupancies can be determined. In addition a new experimental technique will be used to identify the quasifree knockout process in the reaction of the Ni ions with the protons of the CH₂ target, by the coincidence detection of the recoiling fast protons. The experiment and its scientific motivation will be presented, together with a status of the data analysis.

Physics Motivation

High Energy, Single-Nucleon Removal as a Spectroscopic Tool



Exclusive measurements



V. Maddalena et al. PRC 63 (2001) 024613
 NSCLMSU - S800 + NaI

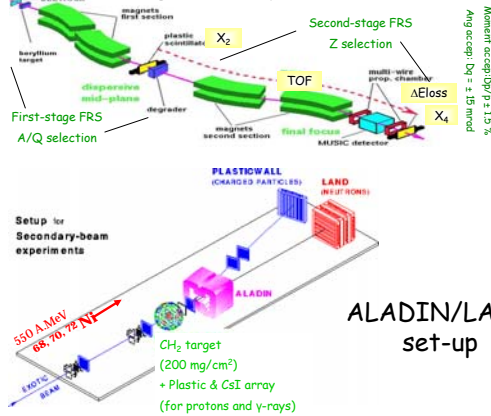
$$\sigma_{sp}(j, B_n) = \sigma_{sp}^{\text{alt}}(j, B_n) + \sigma_{sp}^{\text{exp}}(j, B_n)$$

$$\sigma(nl^{\pi}) = \sum C^2S(j, n l^{\pi}) \sigma_{sp}(j, B_n)$$

Experimental set-up



FRAGment Separator (FRS)



ALADIN/LAND set-up

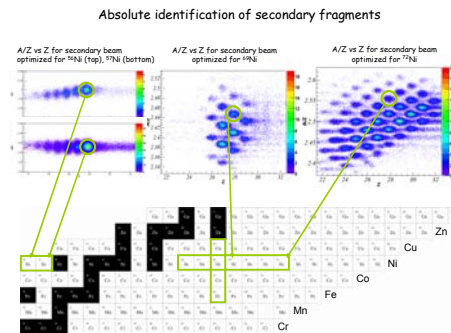
Data Analysis

Isotope Identification of Cocktail-Beam

$$A/Z = \frac{e B \rho}{m_u c \beta \gamma} \quad B \rho = B \rho_0 \left(1 + \frac{\Delta r}{d}\right)$$

$$\beta = \frac{PATH}{(TOF_{SS-POS})C}$$

$$Z \approx f(\beta) \cdot \sqrt{\Delta E}$$



Future Work

Track all particles before and after the reaction on the secondary CH₂ target. momentum distributions of the projectile fragments

angular momentum of the removed nucleon.

partial cross section

Identify final states

γ -ray tagging

Extract spectroscopic factors for ^{56,57,58}Ni which are well known to verify the technique, and then extract spectroscopic factors of exotic nuclei around N ~ 40.

Identify the quasifree knockout process by the coincidence detection of the recoiling fast protons.